DATA MINING TECHNIQUES FOR KNOWLEDGE DISCOVERY IN INFORMATION MANAGEMENT AND SERVICE DELIVERY IN NATIONAL OPEN UNIVERSITY LIBRARIES

Ifeoma Abigail AJIE
National Open University of Nigeria

Patricia Ngozi OFODU
National Open University of Nigeria

Smart Eromosele AMBROSE
National Open University of Nigeria

Loveth Ogoegbunam EKWUEME
National Open University of Nigeria

Babarotimi Opeyemi OLUWASEUN
National Open University of Nigeria

Abstract

This study examines the data mining techniques for knowledge delivery in information management and service delivery in National Open University, libraries. The research questions were: what are the data mining techniques used in academic libraries for Information Management, knowledge discovery, and Service Delivery in Academic Libraries? What are the skills and competencies required by librarians to effectively use data mining techniques for knowledge discovery? & what are the various ways data mining techniques can be used in academic libraries? The study adopted quantitative research methodology and area consisted of one hundred and sixty-eight (168) academic librarians from all the study centers in South East of National Open University of Nigeria. Data was collected using a Goggle Form questionnaire, and one hundred and six (106) responses were collected and analyzed using SPSS. The analysis included descriptive statistics such as mean scores, standard deviation as well as regression analysis to test hypothesis. The study's findings revealed that librarians need to possess technical competency in algorithms and have a wide range of abilities such as domain-specific knowledge in library science, strong analytical skills, and good communication abilities in order to use data mining techniques for knowledge discovery in academic libraries. The study concluded that the fact that these abilities are so widely valued highlights how crucial it is to use data mining to enhance decision-making and library services. The study recommended that academic Libraries should invest in professional development programs to enhance their librarians' technical proficiency in algorithms, analytical skills, and communication. Prioritize Python training for handling large datasets. Integrate data mining techniques into daily operations to improve service delivery, resource management, and user satisfaction; develop customized learning resources for different professional ranks; encourage collaboration and

networking among librarians to share best practices; address data security concerns through robust monitoring systems and continuously evaluate and improve the impact of data mining on services to ensure effective utilization.

Keywords: Data Mining, Data Mining Techniques, Knowledge Discovery Information Management Service Delivery National Open University Libraries

Introduction

Data mining is an advanced process of collecting meaningful information from large amounts of data. It requires skills involving information and communication technology (ICT) competencies for efficiency. Amran, Aldheleai and Al-Sanabani (2021) opined that data mining is an analysis (often large) of observational data sets to find unexpected relationships and to summarize the data in new ways that are understandable and useful to the data owner. There are mining tasks that need to be considered and use in knowledge discovery database such are classification, cluster identification, change and deviation detection and mining association rules. The data mining tasks depend on the type of knowledge the KDD system is looking for. Each data mining task has its specificities and follows specific steps in the discovery process. Furthermore, Mourad, et at. (2021) inferred that data mining refers to the extraction or "Mining" knowledge from large amount of data or data warehouse, to do this extraction data mining combines artificial intelligence, statistical analysis and database management systems to attempt to pull knowledge form stored data.

A similar mining that is close to data mining is web mining, which is the same type of extraction of knowledge from web data for use as information. Web mining is a type of application used to obtain data and extract knowledge from web data so that at least one or more structure or usage data is used in the mining process, with or without other web mining process (Amran, Aldheleai & Al-Sanabani, (2021). Data mining and knowledge discovery are closely linked because as long as the miner (mineworker) of information is working, some knowledge and information obtained must be managed by specialists to support and service customers quickly. Sun (2022) posited that data mining/knowledge discovery is the most important method for locating and accessing hidden information, which is employed in practically every aspect of life and all industries, including organizations, institutions, medical sciences, and research. This method improves information management activities, leading to professional services those clients may use to meet their information needs more easily.

Data mining addresses a new stage in information management and service delivery by altering library activities and meeting user needs. It genuinely uses information in a retrievable manner to benefit academic libraries in the digital age. Mourade et al. (2021) stated that data mining techniques are used in a wide range of domains where large amounts of data are available for the identification of unknown or hidden information. When used in the World Wide Web (WWW), they are called web mining; when used in text, they are called text mining; and when used in libraries, they are called bibliomining. Information management is the systematic organization, classification, storage, retrieval, and dissemination of information within the library for easy retrieval of any necessary information by library users. Knowledge management is the

process of identifying the types of knowledge required by a student and using information technology to help organize, store, and retrieve information. Librarians play an important role in organizing, managing, and providing access to information resources in a variety of educational, research, and organizational settings (Siddiqua, Ansari & Ansari, 2021). If a user enters the library but does not receive the information he or she requires, the user becomes puzzled, and the library's image suffers.

Academic libraries benefit greatly from certain data mining approaches, as they are very useful for information management and service delivery. These approaches improve information accessibility, retrieval, and use both within and outside the library. Data mining and knowledge discovery rely heavily on strategies for uncovering and making available previously hidden information. Librarians with high competency in ICT explore deeper through the web to find the information required by patrons, organize it, package it effectively, and strategize ways to make it more accessible to users.

Knowledge discovery will improve information organization and management for quick access and retrieval, taking library service delivery to a new level. The delivery of information services to users is highly required to work efficiently and effectively in libraries and information centers, especially in academic libraries where students have a variety of information needs (Ntuboderia, Wiche & Onyema, 2023). The provision of service delivery in university libraries seeks to satisfy the needs of users in teaching, research, and learning, and librarians need navigation and selection skills to browse through the web and select relevant sources to improve their service delivery of information to their clientele (Onuoha & Chukwueke, 2019).

Statement of the Problem

Data mining enhances the process of discovering knowledge, resulting in a wealth of data and information that can be managed and utilized to effectively meet the information requirements of users. However, the efficiency and effectiveness of any library's operations and services, irrespective of its type and user community, are determined by the success with which the library can provide and satisfy its diverse user's information needs timely and accurate is lacking as observed by the researchers. This called for attention with respect to data mining techniques in the course of knowledge discovery and information management in National Open University (NOUN) libraries. Thus, the study investigated the Data mining techniques for knowledge discovery in information management and service delivery in National Open University Libraries.

Research Questions
1. What are the data mining techniques used in academic libraries for Information Management, knowledge discovery, and Service Delivery in NOUN Libraries?
2. What are the skills and competencies required by librarians to effectively use data mining techniques for knowledge discovery in NOUN libraries?
3. What are the various ways data mining techniques can be used in NOUN libraries?

Literature Review

Data mining and artificial intelligence are expected to have a significant impact on various businesses in the next three to five years (Georgieva-Trifonova & Dechev, 2021). Data mining involves six key techniques: classification, estimation, prediction, affinity grouping, clustering, and description. Classification categorizes new items into established groups, while estimation deals with variables with continuous values, and categorization with variables with distinct values. Prediction forecasts future behavior or worth, affinity grouping identifies strong compatibility, clustering group populations with similar characteristics, and description enhances understanding of data by recording activities in a complex database (Zhang, 2021). Data mining techniques such as communication rules, text mining, clustering, and neural networks can be employed in academic libraries. Communication rules help identify usage patterns by inferring relationships between items. Clustering is used to explore relationships in customer book-loan data, while neural networks model input-output relationships without requiring a full understanding of the underlying process. Data mining, sometimes known as the knowledge discovery process, is a way to extract useful information from massive databases. Data that has previously been collected for several purposes is usually the focus of knowledge extraction, data/pattern analysis, knowledge mining from data, or data in lieu of information mining. Data mining is a process that improves data management and service delivery by utilising various algorithms and methodologies to discover insights in big datasets. Information can be categorised and user behaviour analysed with the use of methods such as text mining, classification, association rule mining, and association rule mining. This helps with resource management and collection growth decisions. (Pratheebha, T., Indhumathi, V., and Megala, S. S. 2021).

According to Ayyanar1, Ashok, and Laurence, (2019), data mining is the process of discovering previously unknown analytical patterns in large datasets. Data mining is the process of extracting useful insights from large datasets by applying several perspectives to them. Data mining is the process of identifying intriguing patterns and relationships in massive databases using modern data analysis techniques. Statistical models are one such kind of instrument. Thus, data mining encompasses not only data collection and processing, but also analysis and prediction. It is becoming increasingly vital to develop highly effective data analysis and interpretation tools in order to extract useful and fascinating information for smart decision-making from the huge amounts of data stored in various repositories, such as files and databases. Data mining is an integral part of Knowledge Discovery in Databases. Data mining can reveal the underlying relationship between seemingly unconnected pieces of information, which will benefit the digital library.

Data mining techniques encompass a range of methods such as association rules, information/knowledge representation, apriori algorithms, classification, clustering, prediction, sequential patterns, and discriminating. The association rule uses machine learning techniques to discover interesting patterns and connections among variables in large datasets, hence discovering frequent occurrences. The apriori algorithm detects patterns in datasets by distinguishing between high and low frequencies. Clustering automatically groups items based on their connected features. This accelerates and improves topic extraction, document retrieval,

and data filtering. (Alizadeh; Sarabi-Jamab, Razmjooy 2021). To make predictions, the relationships between independent factors and the dependent variable must be determined. Sequential patterns analyse data across time to identify comparable patterns and trends that can be used to improve business planning. Discrimination necessitates assessing fundamental characteristics and developing rules for identifying classes. In libraries, borrowers are categorized as frequent or infrequent based on their borrowing habits. Frequent borrowers borrow items regularly, while infrequent borrowers borrow less often. This distinction helps libraries tailor their services to meet the needs of each group (Nalawade and Joshi, 2021).

Wang et al. (2020) stated that data mining techniques are utilised in academic libraries to manage information and enhance service delivery. These approaches enable the assessment of user behaviours, such as borrowing patterns, search terms, and resource usage. The utilisation of this data can be advantageous for both library collections, services, and the experiences of patrons. By comprehending the resources that are utilised most frequently, libraries can enhance their decision-making regarding resource allocation and purchase. Data mining can assist in the construction of collections by analysing consumption trends and finding areas where there is a lack of data. Libraries can utilise this data to enhance their decision-making process on the addition or removal of materials from their collections. According to Dwivedi and Bajpai (2013), academic libraries utilise data mining to create recommendation systems that analyse user preferences and interests to tailor suggestions to specific users. In academic libraries, data mining techniques are used to manage information and offer services efficiently. These technologies can enhance the user experience overall and increase the visibility of resources.

Enhancing the discoverability and searchability of library resources can be achieved through the application of data mining techniques to augment their metadata. Applications for data mining include resource classification and keyword extraction from articles. Libraries can improve staff scheduling and inventory management by utilising data mining. Optimising and enhancing library operations can be achieved through the analysis of data on personnel availability and resource utilisation. Data mining techniques are employed in academic libraries to create user profiles based on the users' library activities. Librarians can better serve the unique needs and preferences of their clients by using these profiles. An application of data mining called predictive analytics can help predict future resource usage and spot problems before they become serious. Libraries can enhance the quality of services they offer and better meet the needs of their patrons by doing this. Analysing the value of library resources and services can be aided by data mining. Based on user input and usage, libraries can assess the efficacy of their services and make necessary modifications. Similar to commercial apps, libraries can employ data mining to create recommendation systems that tailor material suggestions to the interests and activities of their patrons. The information management and service provision of academic libraries could be greatly enhanced by data mining techniques. (Hussain & Mahmood 2023)

To effectively utilize data mining techniques for knowledge discovery in libraries, librarians need technical proficiency in algorithms like association, classification, and clustering (Tipawan and Pachisa, 2020). Domain-specific knowledge in library science and strong analytical skills are crucial for interpreting data mining results accurately. Effective

communication skills are essential for conveying insights to stakeholders. Libraries house extensive data collections that necessitate ongoing careful management (Zhan, 2016). Librarians must possess strong data sharing skills to handle the expanding volume of data. Working together and utilizing networks can enhance librarians' understanding of datasets, fostering improved internal teamwork and user support. The integration of data mining techniques, encompassing basic data mining, text mining, data analytics, and programming language proficiencies, has emerged as a central component in the educational programs of library and information science (LIS) schools globally (Katsurai and Joo, 2021). These competencies are indispensable for future librarians to adeptly navigate the extensive information landscape prevailing in the digital era.

Data mining assumes a pivotal role in augmenting information literacy within libraries by facilitating the extraction of valuable insights and knowledge from data and text, thereby fostering the creation of knowledge products and bolstering decision-making processes in knowledge organizations (Yan et al., 2020). Librarians can leverage data mining to discern user sentiments, preferences, and trends, thus enabling them to tailor library services and resources more effectively to meet user requirements (Jayasekara and Abu, 2018). One critical facet of data mining is sentiment analysis, which aids in understanding users' sentiments and preferences based on their engagements with library resources and services. Librarians can utilize text mining to bolster online learning platforms, scrutinize chat feeds, and monitor social media sentiments to enhance user engagement and satisfaction (Brahimi et al., 2016 & Dina et al., 2021).

Proficiency in programming languages such as Python is essential for librarians to analyze extensive datasets and conduct sentiment analysis. By honing these skills, librarians can gather real-time data, scrutinize user interactions, and enhance the overall efficiency and efficacy of library services (Surya Gunawan et al., 2020). Librarians must cultivate competencies in data mining, text mining, data analytics, and programming languages to effectively leverage the potential of data for knowledge discovery and decision-making in libraries. These skills are imperative for librarians to remain pertinent and address the evolving information needs of users in the digital era.

Data mining and text mining are essential tools for libraries seeking to understand and meet patron needs (Hussain & Ahmad, 2021). Data mining involves extracting meaningful information from databases through pattern analysis and machine learning algorithms, aiding in the development of more effective services and marketing strategies (Himanti & Kumar 2022). Text mining, on the other hand, focuses on extracting relevant information from unstructured data sources. In recent years, data mining has gained popularity in social science disciplines like library and information science due to its ability to uncover hidden patterns in large datasets (Thakur & Vinit Kumar, 2020; Kaur & Dharni, 2022). This approach helps researchers discover new insights and trends, enhancing the quality and quantity of library services. Different data mining techniques, such as association, classification, clustering, prediction, and discrimination, offer unique advantages for libraries, for example, association techniques can determine user preferences by analyzing circulation history and reading habits. Classification techniques can

predict book purchases based on subject interests, while clustering techniques can group books with similar characteristics for easier access. Data mining techniques offer libraries valuable tools for improving services, understanding user behavior, and making informed decisions (Manjarres et al., 2018; Nalawade & Joshi, 2021).

Methodology

The study area adopted quantitative research methodology and survey design covering all the librarians in National Open University Libraries in the Southeast, Nigeria. The population for the study is one hundred and sixty-five (168) librarians from the NOUN Libraries. The Google Form questionnaire was used for the collection of data. The Google Form questionnaire was sent to all the librarians' email and in their WhatsApp group account. One hundred and six (106) out of one hundred and sixty-five (168) respondents filled the form correctly and submitted. The study utilized Statistical Packages for Social Sciences (SPSS) to analyze the responses, which were coded in a spreadsheet. The data was organized in tables based on the questionnaire and analyzed using Simple percentage (%), Mean (x) scores, and Standard Deviation (SD). Analysis values were assigned to the four response categories, and the mean was interpreted in line with the 4-point scale ranging from (4) highest to (1) the lowest. In decision making, the lower limit of the high degree response category, which was 2.50, was used as a cutoff. Any item with a mean response of 2.50 and above was accepted as an influencing factor. Linear regression was used in testing the hypotheses, and the results were based on a P-value of 0.05 benchmark where the level of significance is above 0.05, it means that there is no significant relationship between the variables.

Analysis of the Tables

Table 1: What are the various ways data mining techniques can be used for information management, knowledge discovery, and service delivery in academic libraries?

Various ways data mining techniques can be used for information management, knowledge discovery, and service delivery in academic libraries	SD	D	A	SA	$\overline{X}$	SD	Dec.
Data mining involves extracting meaningful information from databases through pattern analysis and machine learning algorithms.	0 (0.0)	0 (0.0)	80 (53.0)	71 (47.0)	3.47	0.50	A
Data mining helps researchers discover new insights and trends in large datasets.	0 (0.0)	0 (0.0)	69 (45.7)	82 (54.3)	3.54	0.50	SA
Data mining involves six key techniques: classification, estimation, prediction, affinity grouping, clustering, and description.	0 (0.0)	1 (0.7)	108 (71.5)	42 (27.8)	3.27	0.46	A
Association techniques in data mining can determine user preferences by analyzing circulation history and reading habits.	0 (0.0)	0 (0.0)	100 (66.2)	51 (33.8)	3.34	0.48	A
Classification in data mining can be used to categorize users and information resources in the library.	0 (0.0)	4 (2.6)	105 (69.5)	42 (27.8)	3.25	0.49	A
Classification techniques in data mining can predict book purchases based on subject interests.	5 (3.3)	3 (2.0)	102 (67.5)	41 (27.2)	3.19	0.63	A
Estimation can be used by librarians to find the best library usage pattern based on past data.	2 (1.3)	2 (1.3)	100 (66.2)	47 (31.1)	3.27	0.55	A
Prediction can be used by librarians to forecast future library usage trends based on historical patterns.	3 (2.0)	2 (1.3)	88 (58.3)	58 (38.4)	3.33	0.61	A

Clustering in data mining groups library users with similar information needs (Selective Dissemination of Information).	0 (0.0)	2 (1.3)	76 (50.3)	73 (48.3)	3.47	0.53	A
Text mining focuses on extracting relevant information from unstructured data sources.	10 (6.6)	6 (4.0)	85 (56.3)	50 (33.1)	3.16	0.78	A
Text mining is an essential tool for libraries seeking to understand and meet patron needs.	0 (0.0)	4 (2.6)	92 (60.9)	55 (36.4)	3.34	0.53	A
Data mining can be used to improve data management and service delivery in the library.	2 (1.3)	0 (0.0)	71 (47.0)	78 (51.7)	3.49	0.58	A
Data mining techniques can be used to enhance research and library services.	0 (0.0)	0 (0.0)	72 (47.7)	79 (52.3)	3.52	0.50	A
Cluster Mean					4.36	0.71	A

Table 1 shows that most respondents agree that data mining is valuable for information management, knowledge discovery, and service delivery in academic libraries. With a mean score of 3.47, it is commonly known that data mining uses pattern analysis and machine learning methods to extract valuable information from huge databases. It also helps academics find new patterns and insights, with a mean score of 3.54. There is broad consensus over the six primary data mining techniques (mean score of 3.2). Classification is effective, with a mean score of 3.25 for classifying users and information resources, and 3.19 for forecasting book purchases based on subject interests. With a mean score of 3.27, estimation determines the optimal library consumption patterns based on historical data, while prediction projects future trends with a mean score of 3.33. Clustering, with a mean score of 3.47, identifies customers with similar information demands. Text mining has a mean score of 3.16, making it essential for extracting valuable information from unstructured data sources; it also has a mean score of 3.34 for comprehending customer expectations. Data mining receives a mean score of 3.49, indicating its usefulness in enhancing research and library services, as well as improving data management and service delivery (3.52). There is broad consensus regarding the value and application of data mining techniques in academic libraries, as indicated by the overall score mean of 4.36 with a standard deviation of 0.71.

Hypothesis 1: There is no significant difference between male and female librarians in perceiving the various ways data mining techniques can be used for information management, knowledge discovery, and service delivery in academic libraries.

Table 2: t-test analysis of the significant difference in the mean ratings of male and female Librarians in Academic Libraries in Nigeria

	N	$\bar{X}$	SD	df	t	Sig.(2tailed) P	Decision
Male	57	3.4507	.32520	149	2.552	0.012	Significant
Female	94	3.3003	.36572				

The table above outlines the t-test analysis for examining whether there is a significant difference between male and female librarians in perceiving the uses of data mining techniques in academic libraries. Given the p-value of 0.012, which is less than the significance level of 0.05, there is sufficient evidence to reject the null hypothesis. Thus, the results indicate that male and female

librarians have significantly different mean ratings in their perceptions regarding data mining techniques in academic libraries.

Table 3: What are the skills and competencies required by librarians to effectively use data mining techniques for knowledge discovery.

The skills and competencies required by librarians to effectively use data mining techniques for knowledge discovery	SD	D	A	SA	$\overline{X}$	SD	Dec.
Technical proficiency in algorithms is crucial for librarians to effectively use data mining.	60 (39.7)	16 (10.6)	70 (46.4)	5 (3.3)	2.13	0.99	D
Domain-specific knowledge in library science is necessary for librarians to effectively utilize data mining techniques.	2 (1.3)	3 (2.0)	97 (64.2)	49 (32.5)	3.28	0.57	A
Strong analytical skills are essential for librarians to interpret data mining results accurately.	0 (0.0)	4 (2.6)	79 (52.3)	68 (45.0)	3.42	0.55	A
Effective communication skills are crucial for librarians to convey insights from data mining to stakeholders.	0 (0.0)	0 (0.0)	84 (55.6)	67 (44.4)	3.44	0.50	A
Analytical skills should be a priority in librarian training to interpret data mining results accurately.	0 (0.0)	0 (0.0)	81 (53.6)	70 (46.4)	3.46	0.50	A
Communication skills training should be provided to librarians to effectively convey insights from data mining.	0 (0.0)	0 (0.0)	86 (57.0)	65 (43.0)	3.43	0.50	A
Librarians should possess technical proficiency in algorithms to ensure effective use of data mining techniques.	0 (0.0)	4 (2.6)	84 (55.6)	63 (41.7)	3.39	0.54	A
Cluster Mean					3.22	0.59	A

Table 3 shows the skills and competencies required for the effective use of data mining techniques for knowledge discovery, which some respondents with x score = 2.13 and SD =0.99 agreed that technical proficiency in algorithms is crucial for effective use of data mining. Some other sets of librarians, with the x score between 3.42 to 3.46 and SD =0.50 to 0.55 also strongly pointed that strong analytical skill could be a desired competency for the use of data mining, effective communication skills, analytical skills and communication skills, should also be a priority. Few respondents envisaged that with a x score 3.39 and SD = 0.54, x= 3.28 and SD = 0.55 has it that the required competency to properly use data mining is possession of technical proficiency in algorithms and domain-specific knowledge in library science respectively.

Hypothesis 2: There is no significant difference between male and female librarians in perceiving the skills and competencies required to effectively use data mining techniques for knowledge discovery

Table 4

	N	$\overline{X}$	SD	df	t	Sig.(2tailed) P	Decision
Male	57	3.2381	.26221	149	0.499	0.619	No Significant
Female	94	3.2143	.29683				

The provided table outlines the t-test analysis for examining whether there is a significant difference between male and female librarians in perceiving the skills and competencies required to effectively use data mining techniques for knowledge discovery. Given the p-value of 0.619,

which is greater than the significance level of 0.05, there is insufficient evidence to reject the null hypothesis. Thus, the results indicate that male and female library staff have similar perceptions regarding the skills and competencies required for the effective use of data mining techniques in knowledge discovery.

Table 5: What are various ways data mining techniques can be used in academic libraries

Item Statement	SD	D	A	SA	$\overline{X}$	SD	Dec.
Data mining techniques can be utilized in knowledge discovery in academic libraries.	0 (0.0)	0 (0.0)	60 (39.7)	91 (60.3)	3.60	0.49	SA
Data mining techniques can be used in decision-making in academic libraries.	2 (1.3)	2 (1.3)	86 (57.0)	61 (40.4)	3.36	0.58	A
Data mining techniques can be incorporated into university libraries' daily operations to improve services and assist research.	0 (0.0)	0 (0.0)	80 (53.0)	71 (47.0)	3.47	0.50	A
Data mining is used to identify trends in resource usage, allowing libraries to tailor their collections to meet the needs of their users more effectively.	0 (0.0)	2 (1.3)	78 (51.7)	71 (47.0)	3.46	0.53	A
Data mining will enhance user services by analyzing user behaviour and preferences.	2 (1.3)	6 (4.0)	76 (50.3)	67 (44.4)	3.38	0.63	A
Data mining can assist in understanding which resources are most in demand, helping libraries allocate their budgets and resources more efficiently.	0 (0.0)	3 (2.0)	75 (49.7)	73 (48.3)	3.46	0.54	A
Libraries can use data mining to identify potential collaborators or research trends, enabling them to provide better support to researchers.	0 (0.0)	2 (1.3)	74 (49.0)	75 (49.7)	3.48	0.53	A
Data mining can improve metadata quality, making resources easier to discover and access.	2 (1.3)	8 (5.3)	72 (47.7)	69 (45.7)	3.38	0.65	A
Libraries can use data mining to evaluate the impact of their services and make data-driven decisions to improve them.	0 (0.0)	3 (2.0)	72 (47.7)	76 (50.3)	3.48	0.54	A
Data mining can help identify suspicious activities, such as unauthorized access or use of library resources.	0 (0.0)	20 (13.2)	83 (55.0)	48 (31.8)	3.19	0.65	A
Cluster Mean					3.43	0.56	A

Table 5 indicated various ways in which data mining techniques can actually be used in academic libraries, which responses indicated with x score =3.60 and Sd =0.49 has the assertion that data mining techniques can be utilized in knowledge discovery. Majority of responded librarians has it with strong notion with x score between 3-46, SD=0.53 to x=3.48 & SD=054 that the usage of data mining techniques could be to identify trends in resource usage, allowing libraries to tailor their collections to meet users' need, the data mining techniques can also assist in understanding which resources are most in demand, data mining techniques be incorporated into university libraries' daily operations to improvise services and assist research, that libraries can use datamining to identify potential collaborators or research trends, enabling them to provide better support researchers and equally, libraries can use it to evaluate the impact of their services and make data -driven decisions to improve them. Few librarians with x score 3.38 & SD=0.65 and x=3.38 & SD=0.63 responded that data mining can improve metadata quality, making resources easier to discover and access, and will also enhance user services by analyzing user behaviour and preferences. A significant number of respondents with x score 3.38 & SD=0.65, x=3.36 & SD=0.58 and x=3.19 & SD=0.65 has it that data mining can enhance user

services by analyzing user behaviour and preferences, data mining techniques can be used in decision-making and equally can help to identify suspicious activities, such as unauthorized access or use of library resources.

Discussion of the Findings
Research Question 1: What are the various ways data mining techniques can be used for information management, knowledge discovery, and service delivery in academic libraries?
The table shows that most respondents agree that data mining is valuable for information management, knowledge discovery, and service delivery in academic libraries. With a mean score of 3.47, it is commonly known that data mining uses pattern analysis and machine learning methods to extract valuable information from huge databases. It also helps academics find new patterns and insights, with a mean score of 3.54. There is broad consensus over the six primary data mining techniques (mean score of 3.2). Classification is effective, with a mean score of 3.25 for classifying users and information resources, and 3.19 for forecasting book purchases based on subject interests. With a mean score of 3.27, estimation determines the optimal library consumption patterns based on historical data, while prediction projects future trends with a mean score of 3.33. Clustering, with a mean score of 3.47, identifies customers with similar information demands. Text mining has a mean score of 3.16, making it essential for extracting valuable information from unstructured data sources; it also has a mean score of 3.34 for comprehending customer expectations. Data mining receives a mean score of 3.49, indicating its usefulness in enhancing research and library services, as well as improving data management and service delivery (3.52). There is broad consensus regarding the value and application of data mining techniques in academic libraries, as indicated by the overall score mean of 4.36 with a standard deviation of 0.71.

Research Question 2: What are the skills and competencies required by librarians to effectively use data mining techniques for knowledge discovery.
The study's findings reveal significant insights into the skills and competencies required by librarians to effectively utilize data mining techniques for knowledge discovery. The table data, combined with existing literature, underscores the importance of several key competencies. The table indicates that technical proficiency in algorithms is viewed as crucial by most the respondents, with 46.4% agreeing and 3.3% strongly agreeing (mean = 2.13, SD = 0.99). However, there is also a notable disagreement (50.3% in total). This mixed response aligns with Tipawan and Pachisa (2020), who highlight the necessity for librarians to be proficient in various algorithms, including association, classification, and clustering. This proficiency is essential for extracting meaningful insights from large datasets. A significant majority of respondents (96.7%) agree or strongly agree that domain-specific knowledge in library science is necessary for effective data mining (mean = 3.28, SD = 0.57). This consensus is supported by Zhan (2016), who emphasizes the need for librarians to manage extensive data collections and apply their domain knowledge to interpret data mining results accurately. The importance of strong analytical skills is evident, with 97.3% of respondents agreeing or strongly agreeing (mean = 3.42, SD = 0.55). Analytical skills are crucial for librarians to accurately interpret data mining results, as noted by Katsurai and Joo (2021), who stress the integration of data analytics into library and information science (LIS) education programs globally. Effective communication

skills are unanimously seen as crucial, with 100% agreement among respondents (mean = 3.44, SD = 0.50). These skills enable librarians to convey insights from data mining to stakeholders effectively. Jayasekara and Abu (2018) emphasize the role of data mining in understanding user sentiments and preferences, which requires clear communication of findings to enhance library services. The study highlights the need for ongoing training and professional development, particularly in analytical and communication skills, as indicated by high agreement levels for both (mean = 3.46, SD = 0.50 and mean = 3.43, SD = 0.50, respectively). This finding aligns with the literature, which calls for targeted professional development programs to enhance librarians' skills in evaluating and selecting appropriate technologies (Katsurai and Joo, 2021). The literature review stresses the importance of programming language proficiency, particularly Python, for data analysis and sentiment analysis (Surya Gunawan et al., 2020). Developing these skills is essential for librarians to handle extensive datasets and leverage data mining techniques effectively. The findings suggest several practical implications. Libraries should invest in professional development programs that enhance librarians' technical, analytical, and communication skills. Additionally, strategic planning should consider the professional rank and qualifications of librarians, as those in higher ranks and with advanced qualifications are likely to be more adept at using 5IR technologies. Customized learning resources and policies supporting continuous professional development will further enhance the integration of these technologies in library services, particularly in open and distance learning environments.

Research Question 3: What are various ways data mining techniques can be used in academic libraries

The study's findings provide a comprehensive understanding of the ways in which data mining techniques can be utilized in academic libraries. By examining the responses and aligning them with the existing literature, we can identify several key areas where data mining can significantly impact library services. The results show a strong consensus among respondents on the utility of data mining for knowledge discovery, with 100% agreeing or strongly agreeing (mean = 3.60, SD = 0.49). This aligns with Hussain and Ahmad (2021), who emphasize that data mining helps libraries understand patron needs and develop effective services. Additionally, 97.4% of respondents believe data mining aids decision-making in libraries (mean = 3.36, SD = 0.58). Data mining's ability to extract meaningful information from large datasets (Himanti & Kumar, 2022) supports this, facilitating informed decision-making processes. Respondents widely agree that data mining can be incorporated into daily operations to improve services and assist research, with 100% agreement (mean = 3.47, SD = 0.50). Libraries can utilize data mining to identify trends in resource usage, tailoring collections to meet user needs more effectively (Thakur & Vinit Kumar, 2020). This view is reinforced by Nalawade and Joshi (2021), who highlight data mining's role in understanding user behavior and making informed decisions. A significant number of respondents (94.7%) agree that data mining enhances user services by analyzing user behavior and preferences (mean = 3.38, SD = 0.63). This is supported by Manjarres et al. (2018), who explain that data mining can help libraries discern user sentiments and tailor services accordingly. Additionally, data mining assists in understanding which resources are most in demand, helping libraries allocate budgets and resources efficiently (mean = 3.46, SD = 0.54). The potential of data mining to identify trends in resource usage and facilitate collaborations is well-recognized, with 98.7% agreement (mean = 3.48, SD = 0.53). According to Kaur and Dharni (2022), data mining techniques like association and clustering can reveal hidden patterns in datasets, aiding libraries in better supporting researchers and identifying potential collaborators. Respondents also highlight the importance of data mining in improving metadata quality (mean = 3.38, SD = 0.65) and evaluating the impact of services to make data-driven decisions (mean = 3.48, SD = 0.54). Text mining, a subset of data mining, is particularly useful for extracting relevant information from unstructured data sources, enhancing resource discoverability (Brahimi et al., 2016). While a lower percentage of respondents (86.8%) agree on the role of data mining in identifying suspicious activities, such as unauthorized access (mean = 3.19, SD = 0.65), it remains a crucial application. Libraries can use data mining to monitor and safeguard against potential security breaches, ensuring the integrity of their services. The findings underscore the importance of integrating data mining techniques into library operations to enhance service delivery, resource management, and user satisfaction. Libraries should invest in training programs to build technical proficiency in data mining and analytical skills among librarians. By leveraging data mining tools, libraries can make informed decisions, optimize resource allocation, and tailor services to meet the evolving needs of their users. Data mining presents numerous opportunities for academic libraries to improve their services and support research efforts. The positive perceptions and high level of agreement among respondents highlight the potential of these techniques to transform library operations and enhance user engagement. Continued investment in data mining capabilities and librarian training will be crucial in realizing these benefits.

Conclusion and Recommendations

The study's findings reveal that to effectively utilize data mining techniques for knowledge discovery in academic libraries, librarians must possess a diverse set of skills and competencies. Technical proficiency in algorithms, domain-specific knowledge in library science, strong analytical skills, and effective communication skills are crucial for extracting meaningful insights and conveying them to stakeholders. The unanimous agreement on the importance of these skills underscores their critical role in leveraging data mining for improved library services and decision-making. Moreover, data mining techniques are widely recognized for their potential to enhance library operations. They aid in knowledge discovery, decision-making, and improving user services by analyzing user behavior and preferences. Data mining helps libraries identify trends, allocate resources efficiently, and improve metadata quality, making resources more accessible. Despite some reservations regarding data mining's role in security, its application in monitoring and safeguarding against unauthorized access is acknowledged as valuable.

The integration of data mining into daily library operations and professional development programs for librarians is essential for maximizing its benefits. The positive perceptions and high level of agreement among respondents highlight the transformative potential of data mining techniques in academic libraries. The researchers recommended that; Professional Development and Training Programs: Libraries should invest in continuous professional development programs focused on enhancing librarians' technical proficiency in algorithms, analytical skills, and communication skills. Training in programming languages, particularly Python, should be prioritized to enable librarians to handle extensive datasets and perform data mining effectively. Integration of Data Mining in Library Operations: Academic libraries should integrate data mining techniques into their daily operations to improve service delivery, resource management, and user satisfaction. Strategic planning should include the development of policies supporting the adoption and use of data mining tools. Customized Learning Resources: Libraries should develop customized learning resources and training materials to address the specific needs of librarians at different professional ranks. This approach will ensure that librarians at all levels have the necessary skills and knowledge to utilize data mining techniques effectively. Enhanced Collaboration and Networking: Libraries should encourage collaboration and networking among librarians to share best practices and insights related to data mining. Utilizing professional networks can enhance librarians' understanding of datasets and improve internal teamwork and user support. Focus on Data Security: While data mining offers numerous benefits, libraries must also focus on addressing security concerns. Implementing robust monitoring systems to detect suspicious activities and unauthorized access is crucial to maintaining the integrity of library services. Continuous Evaluation and Improvement: Libraries should continuously evaluate the impact of data mining on their services and make data-driven decisions to improve them. Regular assessments will help identify areas for improvement and ensure that data mining techniques are effectively utilized.

References

Alizadeh, M., Sarabi-Jamab, A., & Razmjooy, N. (2021). A New Apriori Algorithm for High Utility Itemsets Mining in a Horizontal Distributed Database. Journal of Information Science and Engineering, 37(1), 109-125.

Amran, G. A., Aldheleai, H. F., & Al-Sanabani, H. (2021). Understanding the Classification of Data Mining and Web Mining. *International Journal of Applied Information Systems* (IJAIS), 12(37). www.ijais.org

Ayyanar,1., K, Ashok K. and Laurence, I. (2019). The Influence of Data Mining Techniques in Library and Information Science. UWU eRepository-Uva Wellassa University, Sri Lanka. UWU Conference Proceedings – UWUCP. International Research Conference of UWU-2019.

Brahimi, B., Touahria, M., & Tari, A. (2016). Data and text mining techniques for classifying Arabic tweet polarity. Journal of Digital Information Management, 14(1), 15-25. Retrieved from www.scopus.com/inward/record.uri?eid=2-s2.0-84969780164andpartnerID=40andmd5=57719abacdba72ad8002405b928bfc8b

Dina, N. Z., Yunardi, R. T., & Firdaus, A. A. (2021). Utilizing text mining and feature-entiment-pairs to support data-driven design automation massive open online course. International Journal of Emerging Technologies in Learning (iJET), 16(1), 134-151. doi: 10.3991/IJET.V16I01.17095

Dwivedi, R. K., & Bajpai, R. P. (2012). Data mining: concepts and techniques. Choice Reviews Online, 49(06), 49–330549–3305. https://doi.org/10.5860/choice.49-3305

Garoufallou, E., & Gaitanou, P. (2021). Big data: opportunities and challenges in libraries, a systematic literature review. *College & Research Libraries*, *82*(3), 410. https://web.p.ebscohost.com/ehost/pdfviewer/pdfviewer?vid=1&sid=5bc18599-b777-4b7c-88de-0327a55ac6af%40redis

Georgieva-Trifonova, T., & Dechev, M. (2021). Applying text mining methods to extracting information from news articles. IOP Conference Series: Materials Science and Engineering, 1031(1), 012054. https://doi.org/10.1088/1757-899x/1031/1/012054

Hamad, F., Fakhuri, H., & Abdel J., S. (2022). Big data opportunities and challenges for analytics strategies in Jordanian Academic Libraries. *New Review of Academic Librarianship*, *28*(1), 37-60. https://web.p.ebscohost.com/ehost/pdfviewer/pdfviewer?vid=1&sid=af02617a-6dc6-4a7b-8fdf-45d9ca69e33e%40redis

Himanti & Kumar, M. (2023). Data Mining to find out the patterns in the data of circulation section log of July, 2022 of Jamia Millia Islamia University library using python.

Library Philosophy and Practice (e-journal). 1-22. https://digitalcommons.unl.edu/libphilprac/7574

Hussain A. & Ahmad P. (2021). Adoption of Smart Technologies in University Libraries of Pakistan: A Qualitative Review. Library Philosophy and Practice (e-journal), 6055. https://digitalcommons.unl.edu/libphilprac/6055

Hussain, A., & Mahmood, K. (2023). Applications of Data Mining Techniques in Academic Libraries: A Review. Library Philosophy and Practice, 1-20.

Jayasekara, P. K., & Abu, K. S. (2018). Text mining of highly cited publications in data mining.

Katsurai, M., & Joo, S. (2021). Adoption of data mining methods in the discipline of library and information science. Journal of Library and Information Studies, 19(1), 1-17. doi: 10.6182/jlis.202106_19(1).001

Kaur J. & Dharni K. 2022. Application and performance of data mining techniques in stock market: A review. Intell Sys Acc Fin Mgmt. 29, 219–241. https://doi.org/10.1002/isaf.1518

Kumar, M. (2023). Data Mining to find out the patterns in the data of circulation section log of July, 2022 of Jamia Millia Islamia University library using python. *Library Philosophy and Practice*, 1-21. https://www.proquest.com/openview/c80b257cf4aea9e44b5ab9c0b99ab9e6/1?pq-origsite=gscholar&cbl=54903

Manjarres, A. V., Sandoval, L. G. M. & Suárez, M. J. S. (2018). Data mining techniques applied in educational environments: Literature review. Digital Education Review. (33), 235-266. https://www.researchgate.net/publication/327134062_Data_mining_techniques_applied_in_educational_environments_Literature_Review

Mourad, H. M., Banu, S. S. Gawali, B. W. & Khaparde, V. S. (2021). Data mining for library service improvement by using an R tools technique: A review. *Natural Volatiles & Essential Oils*, 8(4).

Mourad, H. M., Banu, S. S., Bharti W. Gawali, B. W. & Khaparde, V. S. (2021). Data mining for library service improvement by using an r tools technique: A review. Nat. Volatiles & Essent. Oils (NVEO) 8(4)

Nalawade, S. L. & Joshi, A. M. (2021). A Literature Review: Data Mining Techniques, Applications & Issues. Aayushi. International Interdisciplinary Research Journal (AIIRJ). 8(4), 31-35. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwj8s-LVhuCEAxUOZkEAHRXHAYIQFnoECC0QAQ&url=https%3A%2F%2Fwww.aiirjou

rnal.com%2Fuploads%2FArticles%2F2021%2F04%2F5104_07.S.%2520L.%2520Nala
wade1%2C.pdf&usg=AOvVaw3plxtAv-hrpKggmHtBsuG7&opi=89978449

Nalawade, S. L. & Joshi, A. M. (2021). A Literature Review: Data Mining Techniques, Applications & Issues. Aayushi. International Interdisciplinary Research Journal (AIIRJ). 8(4), 31-35. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact =8&ved=2ahUKEwj8s-LVhuCEAxUOZkEAHRXHAYIQFnoECC0QAQ&url=https%3A%2F%2Fwww.aiirjou rnal.com%2Fuploads%2FArticles%2F2021%2F04%2F5104_07.S.%2520L.%2520Nala wade1%2C.pdf&usg=AOvVaw3plxtAv-hrpKggmHtBsuG7&opi=89978449

Ntuboderia, D. G., Wiche, H. I, & Onyema, N. (2023). Librarians' ICT skills and effective library service delivery in university libraries in RIVERS STATE. Library Philosophy and Practice (e-journal). https://digitalcommons.unl.edu/libphilprac/7501

Onuoha, J. & Chukwueke, C. (2019). Emergent trends in library services delivery: The application of information and communication technologies in academic libraries. Library Philosophy and Practice (e-journal). 2602. https://digitalcommons.unl.edu/libphilprac/2602

Pratheebha, T., Indhumathi, V., & Megala, S. S. (2021). An empirical study on Data mining Techniques and its Applications. International Journal of Software & Hardware Research in Engineering, 9(4). https://doi.org/10.26821/ijshre.9.4.2021.9410

Sengupta, S. (2017). Applications of data mining in library & information centres: an overview. *International Journal of Current Research*, *9*(01), 45246-45249. http://eprints.rclis.org/34210/

Siddiqua, N., Ansari, H., & Ansari, M. N. (2021). Changing Role of Librarian in Knowledge Management: A Survey of Public Sector Universities. Library Philosophy and Practice (e-journal). 5934. https://digitalcommons.unl.edu/libphilprac

Sun, W. (2022). Data Mining in the Big Data Era. ATLANTIS PRESS. Advances in Social Science, Education and Humanities Research, 664. - http://creativecommons.org/licenses/by-nc/4.0/

Surya Gunawan, T., Aleah Jehan Abdullah, N., Kartiwi, M., & Ihsanto, E. (2020). Social network analysis using Python data mining.

Thakur, K. & Vinit Kumar (2020). An Overview of Text Mining: Application and Free Software Tools. Library Waves, 6(2), 53-59. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact =8&ved=2ahUKEwjyuKCShuCEAxUIQkEAHfabB4AQFnoECBkQAQ&url=https%3 A%2F%2Flibrarywaves.com%2Findex.php%2Flw%2Farticle%2Fdownload%2F90%2F 92&usg=AOvVaw3xTaAUvqVVXIJmQp60L3fp&opi=89978449

Tipawans, S. & Pachisa, K. (2020). Mining and Analyzing Patron's Book-Loan Data and University Data to Understand Library Use Patterns. International Journal of Information Science and Management. (18)2, 151-172. https://doi.org/10.22034/ijism.2023.1977879.0

Uppal, V., & Chindwani, G. (2013). An Empirical Study of Application of Data Mining Techniques in Library System. International Journal of Computer Applications, 74(11), 42–46. https://doi.org/10.5120/12933-0008

Wang, W., Meng, L., Wu, L., & Zhang, J. (2020). Research and Application of Data Mining Technology in Library Office Information Construction. Journal of Physics: Conference Series, 1550(3), 032001. https://doi.org/10.1088/1742-6596/1550/3/032001

Yan, Y., Chen, J., & Wang, Z. (2020). Mining public sentiments and perspectives from geotagged social media data for appraising the post-earthquake recovery of tourism destinations. Applied Geography, 123, 102306. doi: 10.1016/j.apgeog.2020.102306

Zhan M. (2016). Exploring the Feasibility of Applying Data Mining for Library Reference Service Improvement : A Case Study of Turku Main Library. CORE. 1-68 Available at:https://core.ac.uk/display/81235479?utm_source=pdf&utm_medium=banner&utm_campaign=pdf-decoration-v1

Zhang, Z. (2021). Mining method of massive data of mobile library under information asymmetry facing large-scare database. Microprocessors and Microsystems, 81, 103730–103730. https://doi.org/10.1016/j.micpro.2020.103730